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Specification

Tempering Method, Control Device and Tempering Device

The invention relates to a method for controlling a temperature, a regulating device, as well as a device for controlling a temperature in accordance with the preambles of claims 1, 4, 21 or 31.

A device and a method for the temperature control of a component of a printing press is known from DE 44 29 520 A1, wherein the temperature of the component is controlled by means of an at least partially circulating fluid. An actuating member, by means of which a mixture ratio between two fluid flows at different temperatures can be adjusted at a feed-in point, is controlled via a temperature measuring point arranged between the feed-in point and the component.

EP 0 886 577 B1 discloses a device and a method for controlling the temperature of a component, wherein a component temperature is monitored by means of sensors and the measured value is sent to a control unit. If the temperature measured at the component differs from a command variable, the control unit lowers or increases the temperature of a coolant in a cooling unit by a defined value, waits for a length of time and repeats the measurement and the mentioned steps until the control variable has again been attained.

A temperature control device for printing presses is known from EP 0 382 295 A2, wherein a temperature of the fluid in an inflow section and a surface temperature of the component whose temperature is to be controlled are detected and supplied to a control device. An manipulated variable

for regulating a mixing motor is determined on the basis of these temperatures, as well as possibly predetermined disturbance variables, such as the paper used, the percentage of dampening agent and target temperatures, which set the relationship between the fluid conducted in the circuit and freshly temperature-controlled fluid.

JP 60-161152 A discloses a cooling device for a roller whose temperature is to be controlled, wherein a surface temperature of the roller, as well as a fluid temperature in the inflow path, are measured and supplied to a regulating device for comparison with a command variable and for controlling a valve.

The object of the invention is based on creating a method for controlling a temperature, a regulating device, as well as a device for controlling a temperature.

In accordance with the invention, this object is attained by means of the characteristics of claims 1, 4, 21 or 31.

The advantages to be gained by means of the invention lie in particular in that the regulating device operates very rapidly and dependably, even over existing extended conveying distances for the temperature control medium. The short reaction time allows the employment in applications and processes with large dynamic components. Thus, the instant temperature control is of great advantage even in cases where it is necessary to follow rapid changes of a temperature command variable and/or where external conditions, such as the energy yield because of friction or external temperatures, change very rapidly.

The rapid regulation in spite of a possibly extended conveying distance for the fluid is achieved for one in that

further regulating circuits, in particular two regulating circuits, underlie a regulating circuit monitoring the temperature at the component. Also, in a simplified embodiment the direct determination of the temperature can be omitted and a further regulating circuit can underlie a regulating circuit monitoring the temperature at the entry to the component. Thus, the regulating path from the location of the preparation of the temperature control medium (mixing, heating, cooling) to the destination, for example the component itself or the entry to the component, is therefore divided into several partial paths and partial running times.

It is of great advantage here that an innermost regulating circuit monitors the temperature of the temperature control medium during its preparation (mixing, heating, cooling) at a very close distance and regulates it, so that an error possibly occurring during processing is already detected at the start of the conveying path and is removed by regulation, and is not detected and steps are only taken when it reaches the component.

Embodiments are of particular advantage wherein a pre-regulation in regard to the heat flow (losses), in regard to the running times, and/or in regard to the number of revolutions of the machine takes place. A further acceleration of the regulating process can be achieved by a pre-regulation in regard to an amplitude excess and/or in regard to the inclusion of the return temperature.

Exemplary embodiments of the invention are represented in the drawings and will be described in greater detail in what follows.

Shown are in:

Fig. 1, a schematic representation of the temperature

control path with a first exemplary embodiment of the regulating device or the regulating process,

Fig. 2, a second exemplary embodiment of the regulating device or the regulating process,

Fig. 3, a third exemplary embodiment of the regulating device or the regulating process,

Fig. 4, a fourth exemplary embodiment of the regulating device or the regulating process,

Fig. 5, a further development of the invention in accordance with Figs. 1 to 4 relating to the inner regulating circuit,

Fig. 6, a further development of the invention in accordance with Figs. 1 to 4 relating to the outer regulating circuit,

Fig. 7, a schematic representation of a running-time based regulator,

Fig. 8, a detail portion of the temperature control path represented in Fig. 1,

Fig. 9, a first exemplary embodiment of a swirling chamber,

Fig. 10, a second exemplary embodiment of a swirling chamber,

Fig. 11, a third exemplary embodiment of a swirling chamber.

The temperature of a component 01 of a machine, for example a printing press, is to be controlled. The component 01 of the printing press is for example a part of a printing group, not represented, in particular an ink-conducting roller 01 of a printing group. This roller 01 can be embodied as a roller 01 of an inking system, for example as a screen roller 01, or as a cylinder 01 of the printing group,

for example as a forme cylinder 01. The device and the method for temperature control described in what follows can be particularly advantageously employed in connection with a printing group for waterless offset printing, i.e. in a printing group without the use of a dampening agent. In a printing group, in particular a printing group for waterless offset printing, the quality of the ink transfer depends particularly on the temperature of the ink and/or of the ink-conducting surfaces (for example the shell faces of rollers 01 or cylinders 01). Moreover, the quality of the ink transfer is also sensitive to a splitting speed, i.e. the number of revolutions of the machine.

Temperature control takes place via a temperature control medium, in particular a fluid, such as water, for example, which is brought into thermal interaction with the component 01 along a temperature control path 02. If the fluid is to flow against the component 01, the fluid can also be a gas or gas mixture, such as air, for example. For temperature control, the fluid is provided to the component 01 in a first circuit 03, flows through or around the component 01, absorbs heat (cooling) or gives off heat (heating) and flows back again, respectively heated or cooled. A heating or cooling unit can be arranged in this first circuit 03, which can be used for providing the desired fluid temperature.

In the advantageous embodiment in accordance with Fig. 1, however, the first circuit 03 is connected as a secondary circuit 03 with a second circuit 04, a primary circuit 04, in which the fluid circulates at a defined and mainly constant temperature Tv, for example a flow temperature Tv. A temperature control device, for example a thermostat, a

heating and/or cooling unit, etc., which provides the low temperature Tv, is not represented here. Fluid can be taken from the primary circuit 04 and metered into the secondary circuit 03 via a connection 05 between the primary and secondary circuits 04, 03 at a first connection point 06 of the primary circuit 04 by means of an actuating member 07, for example a controllable valve 07. Depending on the addition of fresh fluid at the connecting point 06, fluid from the secondary circuit 03 is returned to the primary circuit 04 via a connection 15 at a second connection point 08. For this purpose, the fluid is for example at a higher pressure level in the area of the first connecting point 06 than in the area of the second connecting point 08. A difference Delta p in the pressure level is generated, for example, by means of an appropriate valve 09 between the connecting points 06, 08.

The fluid, or a larger portion of the fluid, is circulated in the secondary circuit 03 by means of a drive mechanism 11, for example by means of a pump 11, a turbine 11 or in another way, on an inflow path 12 through the component 01, a return flow path 13 and a partial path 14 between the inflow and return flows paths 12, 13. Depending on the inflow via the valve 07, after passing through the component 01, an appropriate amount of fluid flows off via the connection 15 into the secondary circuit 04, or an appropriately reduced amount of fluid through the partial path 14. The portion flowing back through the partial path 14 and the portion freshly flowing in via the valve 17 at a feed-in or injecting point 16 are mixed and now constitute the fluid which is specifically temperature-controlled for the temperature control process. For improving the

intermixing, a swirling section 17, in particular a swirling chamber 17, is arranged as closely as possible downstream of the injection point 16, in particular between the injection point 16 and the pump 11.

In the above mentioned case, wherein temperature control is not performed by means of a primary circuit 04, but by means of a heating or cooling unit, the feed-in or injection point 16 corresponds to the location of the energy exchange by means of the respective heating or cooling unit, and the actuating member 07 for example to an output control or the like. The connecting point 10 in the circuit 03 is omitted, since the fluid circulates altogether in the circuit 03, and energy is supplied or removed, or heat or cold is "fed in" at the feed-in point 16. In this case the heating or cooling unit corresponds to the actuating member 07, for example.

It is intended in the end by means of the temperature control to set or maintain a defined temperature Θ_3 of the component 01, in particular in the case of a cylinder 01 the surface temperature Θ_3 on the roller 01, to a defined command variable $\Theta_{3,soll}$. This is achieved by measuring a statement-capable temperature on the one hand, and a regulation of the supply of fluid from the primary circuit 04 to the secondary circuit 03 for creating an appropriate mix temperature on the other hand.

It is now important that at least two measuring points M1, M2, M3 with sensors S1, S2, S3 are provided in the instant device or by the instant method between the injection point 16 and an exit of the component 01 to be temperature-controlled, wherein one of the measuring points M1 is arranged near the injection point 16, and at least one of the

measuring points M2, M3 in the area close to the component of the inflow path 12 and/or in the area of the component 01 itself. As a rule, the valve 07, the pump 11, the injection point 16, as well as the connecting points 06, 08 are arranged spatially close to each other and for example in a temperature control cabinet 18, indicated by dashed lines. As a rule, the inflow and return flow paths 12, 13 between the component 01 and the not explicitly represented exit from or entry into the temperature-control cabinet 18 have a comparatively great length in regard to the other paths, which is indicated in Fig. 1 by respective interruptions. The locations for the measurements have now been selected in such a way that at least respectively one measuring point M1 is arranged in the vicinity of the temperature control cabinet 18, and one measuring point M2, M3 near the component, i.e. at the end of the long inflow path 12.

In the exemplary embodiment in accordance with Fig. 1, the measurement of a first temperature Θ_1 is performed between the injection point 16 and the pump 11, in particular between a swirling section 17 and the pump 11, by means of a first sensor S1. A second temperature Θ_2 is determined by means of a second sensor S2 in the area of the entry into the component 01. In Fig. 1, the temperature Θ_3 is also determined by measurement, namely by means of an infrared sensor (IR sensor S3) directed onto the surface of the roller 01. The sensor S3 can also be arranged in the area of the shell face or, as explained below, possibly also be omitted.

Temperature control takes place by means of a regulating device 21, or a regulating process 21, which will be described in greater detail in what follows. The regulating device 21 (Fig. 1) is based on a multi-loop, here

a triple-loop cascade regulation. An innermost regulating circuit has the sensor S1 shortly downstream of the injection point 16, a first regulator R1 and the actuating member 07, i.e. the valve 07. The regulator R1 is provided with a deviation Delta Θ_1 of the measured value Θ_1 from a (corrected) command variable $\Theta_{1,soll,k}$ (node K1) as the input value and acts in accordance with its implemented regulation behavior and/or regulation algorithm with an actuating order Delta on the actuating member 07. This means that, depending on the deviation of the measured value Θ_1 from the corrected command variable $\Theta_{1,soll,k}$, it opens or closes the valve 07 or maintains the position. The corrected command variable $\Theta_{1,soll,k}$ is now not directly specified by a control device or manually, as is otherwise customary, but is formed with the use of an output value from at least one second, further "outward" located regulating circuit. The second circuit has the sensor S2 shortly prior to the entry into the component 01, as well as a second regulator R2. The regulator R3 is provided with a deviation Delta Θ_2 of the measured value Θ_2 at the sensor S2 from a corrected command variable $\Theta_{2,soll,k}$ (node K2) as the input value, and at its output generates a value $d\Theta_1$ (output value $d\Theta_1$) in accordance with its implemented regulation behavior and/or regulation algorithm, which is used for forming the above mentioned corrected command variable $\Theta_{1,soll,k}$ for the first regulator R1. This means that, depending on the deviation of the measured value Θ_2 from the corrected command variable $\Theta_{2,soll,k}$, an influence is brought to bear by means of the value $d\Theta_1$ on the corrected command variable $\Theta_{1,soll,k}$ of the first regulator R1 to be formed.

In a preferred embodiment, the corrected command

variable $\Theta_{1,soll,k}$ for the first regulator R1 is formed at a node K1' (for example addition, subtraction) from the value $d\Theta_1$ and a theoretical command variable $\Theta'_{1,soll}$. In turn, the theoretical command variable $\Theta'_{1,soll}$ is formed in a pre-regulation member in regard to the heat flow V_{WF}. The pre-regulation member V_{WF}, in this case $V_{1,WF}$ (subscript 1 for forming the command variable of the first regulating circuit), takes the heat exchange (losses etc.) of the fluid on a partial path into consideration and is based on empirical values (expert knowledge, calibration measurements, etc.). In this way the pre-regulation member $V_{1,WF}$ takes the heat or cooling losses along the partial path between the measuring points M1 and M2 into consideration in that it forms an appropriately raised or lowered theoretical command variable $\Theta'_{1,soll}$, which is then processed, together with the value $d\Theta_1$, into the corrected command variable $\Theta_{1,soll,k}$ for the first regulator R1. A connection between the input value (command variable $\Theta_{3,soll}$ or $\Theta'_{2,soll}$ or $\Theta'_{2,soll,n}$, see below) and a corrected output value (modified command variable $\Theta'_{2,soll}$ or $\Theta'_{2,soll,n}$, see below, or $\Theta'_{1,soll,n}$) is fixedly stored in the pre-regulation member V_{WF}, which can preferably be changed by means of parameters or in another way, as needed.

In principle a simple embodiment of the regulating device is possible, wherein only the two first mentioned regulating circuits form the cascade regulating device. In this case the pre-regulation member $V_{1,WF}$ would be specified as the input value by a machine control device, or a defined command variable $\Theta_{2,soll}$ manually. It would also be used for forming the above mentioned deviation Delta Θ_2 upstream of the second regulator R2.

However, in the embodiment represented in Fig. 1, the

regulating device 21 has three cascaded regulating circuits. The corrected command variable $\Theta'_{2,soll,k}$ upstream of the second regulator R2 is now also not directly specified, as otherwise customary, by a control device or manually, but is formed with the use of an output value from a third outer regulating circuit. The third regulating circuit has the sensor S3, which detects the temperature on, or in the area of, the shell face, as well as a third regulator R3. The regulator R3 is provided with a deviation Delta Θ_3 of the measured values Θ_3 at the sensor S3 from a command variable $\Theta_{3,soll}$ (node K3) as the input value, and corresponding to its implemented regulation behavior and/or regulation algorithm, it generates at its output a value $d\Theta_2$ correlated with the deviation Delta Θ_3, which is also used for forming the above mentioned corrected command variable $\Theta_{2,soll,k}$ for the second regulator R2. This means that, depending on the deviation of the measured value Θ_3 from the command variable $\Theta_{3,soll}$ (or a corrected command variable $\Theta''_{3,soll}$, see below) specified by a machine control device or manually entered, influence is brought to bear by means of the value $d\Theta_2$ on the corrected command variable $\Theta_{2,soll,k}$ of the second regulator R2 to be formed.

The corrected command variable $\Theta_{2,soll,k}$ for the second regulator R2 is formed at a node K2' (for example addition, subtraction) from the value $d\Theta_2$ and a theoretical command variable $\Theta'_{2,soll}$ (or $\Theta''_{2,soll}$, see below). In turn, the theoretical command variable $\Theta'_{2,soll}$ is formed in a pre-regulation member in regard to the heat flow V_{2WF}. The pre-regulation member V_{2WF}, for example takes the heat or cooling losses on the partial path between the measuring points M2 and M3 into consideration by forming an appropriately raised

or lowered command variable $\Theta'_{2,soll}$ which then, together with the value $d\Theta_2$, is processed as the corrected command variable $\Theta_{2,soll,k}$ for the second regulator R2.

Thus, the described method is based for one on the measurement of the temperature directly downstream of the injection point 16, as well as at least one measurement close to the component 01 whose temperature is to be controlled. Secondly, a particularly short reaction time of the regulation is achieved in that several regulating circuits interact in a cascade-like manner and that already in the course of the command variable formation for the inner regulating circuit, a measured value Θ_2, Θ_3 is taken into consideration. Thirdly, a particularly short reaction time is achieved by pre-regulation, which provides empirical values for losses to be expected on the temperature control path 02. Thus, a regulation circuit located closer to the actuating member 07 is already provided with a command variable appropriately raised or lowered by an empirical value in expectation of losses.

In an advantageous embodiment in accordance with Fig. 2, the regulating device 21 has further pre-regulation devices besides the pre-regulation member in regard to heat flow $V_{1,WF}$, $V_{2,WF}$.

As can be seen in Fig. 1, the fluid requires a final running time T_{L2} for the path from the valve 07 to the sensor S2. Moreover, in the course of actuating the actuating member 07, the respective mix temperature does not immediately change to the desired value (for example inertia of the valve, heating or cooling of the pipe walls and pump), but instead is subject to a time constant T_{e2}. If this, as in the embodiment in accordance with Fig. 1, is not taken

into consideration, increased fluctuations of the regulating device can occur, since for example a command for opening the valve 07 was given, but the result of the opening, namely respectively warmer or colder fluid, might not have reached the measuring location of the measuring point M2, so that the respective regulating circuit continuous to erroneously issue further actuating command for opening.. The same applies to the path from the valve 07 to the detection of the temperature by the sensor S3 with the running time T'_{L3} and a time constant T'_{e3}, wherein here the marked reference symbol indicates that this need not be the time until the detection of the fluid temperature in the area of the roller shell face, but the time until the detection of the temperature of the roller surface or the roller shell.

Based on the idle time (corresponds to running time T_{L2} or T'_{L3}) and the time constant T_{e2} or T'_{e3}, the path reactions to the activities of the innermost regulator R1 toward the level of the two outer regulators R2, R3 do not become immediately visible. In order to avoid, or prevent, a double reaction of these regulators caused by this, which would be exaggeratedly wrong and could not be recovered, a pre-regulation member in regard to the running time and/or the time constant V_{LZ} in the form of a path model member is provided in one or several of the control circuits in the course of forming the command variable, by means of which the expected "natural" delay in the result of a change at the actuating member 07 is taken into consideration. The running time actually required by the fluid (on the basis of empirical values or preferably by measured value recordation, or calculated estimates) is simulated in the regulation by means of the pre-regulation member in regard to the running

time and/or the time constant V_{LZ}. Now the outer regulators M2, M3 only react to those deviations which, taking into consideration the modeled path properties, are not expected and therefore actually require repair. The outer regulators R2, R3 are "blinded" by this symmetrization to the regulation deviations which are expected anyway and are physically unavoidable, and of which the innermost regulator R1 already takes care "locally". In this way the "pre-regulation member" V_{LZ} acts in the manner of a "running time and delay member" V_{LZ}. The mentioned dynamic property (running time and delay) is mapped in the pre-regulation member V_{LZ} and permanently stored, but can preferably changed as needed by means of parameters or in another way. To this end appropriate parameters T^*_{L2}, T^*_{e2}, T^*_{L3}, T^*_{e3}, which are intended to simulate and represent, for example the actual running time T_{L2}, T'_{L3} and/or the replacement constant T_{e2}, T_{e3}, can be adjusted at the pre-regulation member V_{LZ}. The adjustment should take place in such a way that with this a virtual dynamic course of the command variable created by calculation, for example the command variable $\Theta''_{2,soll}$ or $\Theta''_{3,soll}$, is compared substantially synchronously in time with the corresponding course of the measured value Θ_2 or Θ_3 of the temperature at the associated sensor S2 or S3 and the node K2 or K3.

For the outer regulating circuit, the virtual changed command variable $\Theta''_{3,soll}$ corresponds to the command variable $\Theta_{3,soll,k}$ which is to be compared with the measured value, since it is not corrected by a further regulating circuit. In the exemplary embodiment, no pre-regulating member V_{LZ} besides it is provided in the innermost regulating circuit (very short paths or running time). In a unification of the

nomenclature, here the command variable $\Theta'_{3,soll}$ therefore represents the command variable $\Theta''_{3,soll}$ without any further changes.

Such a pre-regulation member V_{LZ}, which represents the path model, is provided at least for forming the command variable for the regulating circuit or the regulating circuits assigned to the sensor S2, or the sensors S2, S3 close to the component. In the example, the two outer regulating circuits have such a pre-regulating member $V_{LZ,2}$, $V_{LZ,3}$ in their command variable formation process. If the path between the valve 07 and the sensor S1 should also prove to be too long and interfering, it is also possible to provide an appropriate pre-regulation member $V_{LZ,1}$ in the command value formation process for the inner regulating circuit.

A further improvement of the regulating dynamics can be achieved with the further development of the mentioned regulating device in accordance with Fig. 3 if the conversion of the desired course of the command variable on the level of the innermost regulating circuit is made faster and with less of a drag distance, by a derivative member $V_{VH,1}$ in the form of a time constant exchanger, for example of the 1st order (lead-lag filter). This pre-regulation in the form of the derivative member $V_{VH,1}$ initially causes an excess of amplitude (overcompensation) in the reaction in order to accelerate the regulating process in the respective start phase, and then returns to neutral.

To prevent any stability problems, this step preferably takes place only in the portion of the command variable not affected by actual values, i.e. ahead of the respective node K1, K2' (addition or subtraction point depending on the

mathematical sign). To maintain this symmetrization at the outer regulators R2, R3, this dynamic step then must be compensated there by means of appropriate derivative members $V_{VH,2}$ or $V_{VH,3}$, which act in addition to the mentioned pre-regulations V_{WF} in regard to the heat flow and V_{LZ} in regard to the running time and/or the time constants during the formation of the command variable of the subsequent regulating circuit.

The property of the course of the mentioned excess increase (in relation to the input signal) is mapped in the pre-regulating member $V_{VH,1}$ and permanently stored, but its size or course can be changed as needed, preferably by means of parameters or in other ways. In accordance with the physical sequence, the derivative member $V_{VH,1}$ in regard to the signal path is preferably arranged ahead of the pre-regulating member V_{LZ} (if provided) and behind the pre-regulating member V_{WF} (if provided). The pre-regulation member V_{VH} in accordance with one of the embodiments of Figs. 1 to 4 can also be used independently of or in addition to the presence of the pre-regulation members V_{LZ}, V_{DZ} or V_{AB} (see below).

In a further development of the regulating devices in accordance with Figs. 1, 2 and 3, a further improvement of the regulation dynamics can be achieved if, in addition to the mentioned pre-regulating devices V_{WF} in regard to the heat flow, in regard to the running time and/or the time constant V_{LZ} and/or the derivative member V_{VH}, a pre-regulation in regard of the number of revolutions of the machine V_{DZ} takes place (Fig. 4). More or less frictional heat is produced in a printing group as a function of the number of revolutions n of the machine. If it is intended to

maintain the mass flow of the fluid substantially constant, increased frictional heat can only be generated via a lowering of the fluid temperature, and vice versa. The above described regulating device would doubtlessly react over time to a change in the frictional heat by lowering or increasing the fluid temperature, but only after the temperature at the sensor S3 indicates the undesired temperature.

In order to further increase the dynamics of the regulating device 21, in particular under changing operating conditions (start-up phase, change in the number of revolutions, etc.), the pre-regulating member V_{DZ} in regard to the number of revolutions is provided, which can basically be superimposed on all lower-order command valuable formations, which therefore have an actuating value character, i.e. the formation of the command variables $\Theta''_{1,soll}$, $\Theta''_{2,soll}$, $\Theta''_{3,soll}$. However, a superimposition of the outer regulating circuit does not make sense as long as the value measured at the sensor S3 represents the technologically final valid actual value (for example the temperature on the effective surface, i.e. the shell face itself). In the exemplary embodiment, the pre-regulating member V_{DZ} only acts on the formation of the command variables $\Theta''_{1,soll}$, $\Theta''_{2,soll}$, namely in that a correction value $d\Theta_n$ is superimposed on the theoretical command variable $\Theta'_{2,soll}$ created in the pre-regulating member $V_{2,WF}$, which is arranged upstream of the second regulating circuit. The command variable $\Theta'_{2,soll,n}$ created from this is used directly, or via appropriate pre-regulation members $V_{VH,1}$ and/or $V_{LZ,1}$, for forming the command variable of the second regulating circuit (R2), and simultaneously via pre- regulating member $V_{WF,1}$, and possibly the pre-regulating member $V_{VH,1}$ for forming

the command variable of the first regulating circuit (R1). A connection between the number n of revolutions of the machine and a suitable correction is permanently stored in the pre-regulating member V_{DZ}, which can preferably be changed as needed via parameters or in other ways. The pre-regulating member V_{DZ} can also be used in one of the embodiments in accordance with Figs. 1 to 4 independently of the presence of the pre-regulating members V_{LZ}, V_{VH} (see below) or V_{AB} (see below), or in addition.

However, if the sensor S3 does not measure the shell face, but a temperature further inside of the component (which technologically is not the final valid temperature), it can also be useful to let the pre-regulation member V_{DZ} also act on the outer regulating circuit (R3). The same applies to an outer regulating circuit which obtains the measured value not directly from the component 01, but from a sensor S4, S5 (see Figs. 1 and 5) arranged after passage through the component 01, and which is possibly linked with the measured value from S2.

In a further development in Fig. 4, a further pre-regulating member V_{AB} in the form of a dynamic model member, for example a rise limiter V_{AB}, in particular non-linear, is provided directly ahead of the node K1 for forming the corrected command variable $\Theta_{1,soll,k}$. It adapts the finite actuating time (not equal to zero) and the actual limitation of the actuating member 07 in respect to its maximal actuating path, i.e. even if a very great change is requested, only a limited opening of the valve 07, and therefore only a limited amount of temperature-controlled fluid can be provided from the primary circuit 04. The mentioned rise limitation (property of the valve) is mapped

in the pre-regulating member V_{AB} and permanently stored, but can preferably be changed via parameters or in other ways, as needed. The pre-regulating member V_{AB} is also usable independently of the presence of the pre-regulating members $V_{LZ,1}$, $V_{VH,1}$ or V_{DZ}, or can be additionally used in one of the embodiments in accordance with Figs. 1 to 3.

Fig. 5 shows a further development of the embodiments up to now of the first regulating circuit, independently of the embodiments in accordance with Figs. 1, 2, 3 or 4. A measured value Θ_5 of a sensor 5 is detected close to or in the area of the partial path 14, i.e. a short distance from the injection point 16, and is additionally used for regulation in the innermost regulating circuit. To this end, the measured value Θ_5 is introduced as the input value into a further pre-regulating member V_{NU} for dynamic zero point suppression. The measured value Θ_5 provides information regarding the temperature with which the returning fluid will be available for the impending mixture with fed-in cooling or heating fluid. If the measured value suddenly greatly changes, for example the temperature drops greatly, a correspondingly opposite signal σ, for example a strong increase of the opening in the valve 07, is created by means of the pre-regulating member V_{NU} and provided to the regulator R1. The re-regulating member V_{NU} therefore causes a counteraction to a change shortly to be expected at the sensor S1 even before it has occurred there. In the ideal case this change will not even occur there because of the application of this interference value.

The functional progress and the amplification of the pre-regulating member V_{NU} regarding this return flow pre-regulation are permanently stored and can preferably be

changed by means of parameters.

Fig. 6 shows a further development of the embodiments up to now of the outer regulating circuit independently of the embodiments in accordance with Figs. 1, 2, 3 or 4. In contrast to the explanations up to now, a measured value Θ_3 from a sensor S3 detecting the surface of the component or located in the shell surface is not used, but instead the measured values Θ_2 and Θ_4 from sensors S2 and S4 near the component in the return flow path 12, 13. These are processed, together with a number of revolutions signal n, in a logical unit L, or in a logical process L, by means of a permanently stored, but preferably changeable algorithm into $\bar{\Theta}_3$ a replacement measured value Θ_3, for example the replacement $\bar{\Theta}_3$ temperature Θ_3 of the component 01 (or its surface). This $\bar{\Theta}_3$ replacement measured value Θ_3 is passed on to the node K3 as $\bar{\Theta}_3$ the measured value, or temperature Θ_3, in place of the measured value Θ_2, corresponding to the above mentioned exemplary embodiments.

The regulators R1, R2, R3 from the exemplary embodiments in accordance with Figs. 1 to 4 are embodied in a simple design as PI regulators R1, R2, R3.

However, in an advantageous embodiment, at least the regulators R2 and R3 are designed as so-called "running time-based regulators" or "Smith regulators". The running time-based regulators R2 and R3, in particular running time-based PI regulators R2 and R3 are represented in Fig. 7 as a replacement circuit diagram and parameterized. The regulator R2, R3 has the deviation Delta Θ_2, Θ_3 as the input value. It is designed as a PI regulator with a parameterizable amplification factor V_R, whose output signal is fed back via a replacement constant member G_{ZK} and a running time member

G_{LZ} (or as a member as represented with the pre-regulation member V_{LZ}).

The running or idle time of the regulating path, as well as its time constant, is mapped in the running time-based PI regulator R2, R3 and permanently stored, but can preferably be changed via parameters or in other ways, as needed. For this purpose, appropriate parameters T^{**}_{L2}, T^{**}_{e2}, T^{**}_{L3}, T^{**}_{e2}, which for example are intended to represent the actual running time T_{L2} or T_{L3}, and/or the time constant T_{e2}, T_{e3}, can be set at the PI regulator R2 and R3. With a correct setting and reproduction of the regulating path, the values of the parameters T^{**}_{L2}, T^{**}_{e2}, T^{**}_{L3}, T^{**}_{e3}, and the values of the parameters T^{*}_{L2}, T^{*}_{e2}, T^{*}_{L3}, T^{*}_{e3} from the pre-regulating members $V_{LZ,1}$ in regard to the running time and the time constant, should substantially agree, since the respective regulating path is described by them in the regulator R2, R3, as well as in the pre- regulation member V_{LZ}. Accordingly it is possible to use running time-based PI regulators R2, R3, as well as pre- regulating members V_{LZ} in the regulating device, and the same parameter sets, once determined, should be used for both.

The first section 12.1 extends from the injection point 16 as far as the first measuring point M1 with the first sensor S1 and has a path length X1, as well as a first average running time T_{L1}. The second section 12.2 extends from the first measuring point M1 up to a measuring point M2 "near the component", with the sensor S2. It has a second path length X2, as well as a second average running time T_{L2}. The third section 12.3 with a third path length X3, as well as a third average running time T_{L3}, adjoins the measuring point M2 and extends to the destination 22 (here the first

contact of the fluid in the area of the extended shell face). A total running time T of the fluid from the injection point 16 to the destination therefore results from $T_{L1} + T_{L2} + T_{L3}$.

The first measuring point M1 has been selected "close to the feed-in point", i.e. at a short distance from the feed-in point 16, here the injection point 16. Thus, a measuring point M1 close to the feed-in point, or a sensor S1 close to the actuating means is understood to be a location in the area of the inflow path 12, which is located in regard to the running time T_L of the fluid less than one tenth, in particular one-twentieth, of the distance from the feed-in point 16 to the first contact with the destination 22 (here the first contact of the fluid in the area of the extended shell face), i.e. $T_{L1} < 0.1$ T, in particular $T_{L1} < 0.5$ T applies. For a high degree of regulation dynamics, the measuring point M1 is located in respect to the running time T_{L1} of the fluid maximally 2 seconds, in particular maximally 1 second, distant from the injection point 16. As already mentioned in connection with Fig. 1, the injection point 16, the sensor S1, as well as the downstream arranged pump 11, are arranged in a temperature-control cabinet 18, which constitutes a structural unit of the contained units. The measuring point M1 is preferably located upstream of the pump 11. The temperature-control cabinet 18 can be connected with the component 01 via releasable connections 23, 24 in the inflow path 12, as well as the return flow path 13.

As a rule, the component 01 and the temperature-control cabinet are not arranged directly adjoining each other in the machine, so that a line 26, for example pipes 26 or a hose 26, from the temperature-control cabinet 18 to an entry 27 into the component 01, for example to a lead-through 27, in

particular a rotary lead-through 27, has a length of appropriate size. The lead-through into the roller 01 or the cylinder 01 is only schematically indicated in Fig. 8. If, as is customary, the roller 01 or the cylinder 01 has a journal at its front face, the lead-through is provided through the journal. The path of the fluid to the shell face, as well as inside the component 01 along the shell face is only symbolically represented and can extend in a known manner, for example in axial or helical conduits, in extended hollow chambers, in a circular ring cross section, or in other suitable ways underneath the shell face. The second measuring point M1 is "close to the component", i.e. selected at a short distance from the component 01, or the destination 22, in this case the shell face. Therefore a second measuring point M2, or a second sensor S2, close to the component, is understood to be a location in the area of the inflow path 12 which, in respect to the running time of the fluids, is farther removed than half the distance from the injection point 16 to the first contact with the destination (here the first contact of the fluid in the area of the extended shell face). $T_{L2} > 0.5$ T applies here. In order to obtain great dynamics of the regulation, simultaneously along with low structural outlay at rotating components 01, the second measuring point M2 is arranged in the area of the line 26 fixed in place, yet outside of the rotating component 01, but is still located directly, i.e. distanced maximally three seconds in regard to the running time of the fluid, upstream of the entry 27 into the component 01.

The third measuring point M3, if provided, is also arranged at least "close to the component", but in particular "close to the destination". This means that it is located in

close vicinity to the destination 22 of the fluid, or directly detects the surface to be temperature-controlled (in this case the shell face of the roller 01). In an advantageous manner the measuring point M3 does not detect the fluid temperature, such as is the case with the measuring points M1 and M2, for example, but the area to be temperature controlled of the component 01 itself. The direct vicinity of the destination 22 is here understood to mean that the sensor S3 is located between the fluid circulating in the component 01 and the shell face, or detects the temperature Θ_3 on the shall face in a contactless manner.

In another embodiment of the temperature-control device it is possible to do without the measuring point S3. It is possible to draw conclusions regarding the temperature Θ_3 from empirical values by means of the measured values of the measuring point M2, for example by means of a stored connection, an offset, a functional interrelationship. Then, for a desired temperature Θ_3 a regulation to a desired temperature Θ_2 is performed, taking into consideration the machine or production parameters (inter alia the number of revolutions of the machine, ambient temperature and/or fluid throughput, (doctor blade) coefficient of friction, heat progress resistance).

In a further embodiment the measuring point 3 is again omitted, but conclusions regarding the temperature Θ_3 are drawn from empirical values by means of the measured values at the measuring point M2 and the measuring point M4, for example again from a stored connection, an offset, a functional interrelationship and/or by forming an average value from the two measured values. Then for a desired temperature Θ_3, a regulation to a desired temperature Θ_2 as

the command variable is performed again, either by taking into consideration the machine or production parameters (inter alia the number of revolutions of the machine, ambient temperature and/or fluid throughput), or to the temperature Θ_3 indirectly determined by means of the two measured values. In Fig. 8, the inflow and outflow of the fluid into or out of the component 01 embodied as a roller 01 or a cylinder 01 are located on the same front face. Accordingly, the rotary leadthrough is embodied here with two connectors or, as represented, with two leadthroughs arranged coaxially inside each other and coaxially in respect to the roller 01. The measuring point M4 is also arranged as closely as possible to the leadthrough.

In the advantageous embodiment of the temperature-control device, it has a swirling section 17, in particular a specially designed swirling chamber 17, in the section 12.1 between the feed-in point 16 and the first measuring point M1. As already mentioned above, the measuring point M1 should be arranged close to the feed-in point, so that as rapid as possible reaction times can be realized in the respective regulation circuit with the measuring point M1 and the actuating member 07. However, on the other hand a homogeneous mixture between the fed-in and the returning fluid (or the heated/cooled fluid) has not yet been achieved closely downstream of the feed-in point, so that errors in the measured values make regulation difficult, and possibly considerably delay reaching of the desired temperature Θ_3 at the component 01.

The employment of the swirling section 17, in particular of the specially designed swirling chamber 17, in accordance with Figs. 9 and 10 assures in a simple manner a

dependably mixing of the fluid over a very short distance, so that the above mentioned requirement regarding a short running time T1 can be met.

Initially, a first cross-sectional change takes place in the smallest structural space, wherein a first cross-sectional surface A1 is suddenly increased by a factor $f1 = 2$ to a second cross-sectional surface A2. Directly adjoining a change in direction of 70° to 110° takes place, in particular abruptly by approximately 90°, which is followed by a second cross-sectional change, namely a reduction from the cross-sectional surface A2 to the cross-sectional surface A3 by a factor f2 ($f2<1$). The factor f2 is advantageously selected as $f2 \leq 0.5$ and has been selected complementary to the factor f1 in such a way that the two cross-sectional surfaces A1, A3 upstream and downstream of the swirling chamber 17 are substantially of the same size.

Fig. 9 shows an embodiment of the swirling chamber 17 with pipe-shaped inlet and outlet areas 29, 31, wherein non-represented pipe-shaped lines with a cross-sectional surface A1 here terminate in centrally arranged openings 32, 33 as the inlet 32 and outlet 33. The joining line of the pipe-shaped inlet and outlet areas 29, 31 does not form a curved pipe with a steadily extending curvature, but instead is embodied with a bent-off edge at least in a plane constituted by the flow directions in the inlet and outlet area (see the bend 36, 37). In a further development, the openings 32, 33 can also be placed non-centered in the surfaces A2, A3.

Fig. 10 shows an exemplary embodiment wherein the swirling chamber 17 is embodied with the geometry of a joint between two box-shaped pipes. Here, again, two surfaces A2 have respective openings 32, 33. Here, too, the directional

change in the area of the existing or "imaginary" joint 34 between the inlet and the outlet surface has been embodied with (sharp) edges (see bend 36, 37). Again, the openings 32, 33 can be asymmetrically arranged in the surfaces A2.

Fig. 11 shows an exemplary embodiment wherein the swirling chamber 17 is embodied with the geometry of a cube, in a special design in Fig. 10 as a cube with identical lengths of the lateral edges. In this case two adjoining surfaces A2 each have the openings 32, 33. Here, too, the direction change in the area of the "imaginary joint" (34) between the inlet and the outlet areas is embodied with (sharp) edges (see bend 36, 37). Here, too, the openings 32, 33 can be asymmetrically arranged in the surfaces A2.

List of Reference Symbols

01	Component, roller, screen roller, cylinder, forme cylinder
02	Regulating path, temperature-control path
03	Circuit, first, secondary circuit
04	Circuit, second, primary circuit
05	Connection
06	Connecting point, first
07	Actuating member, valve
08	Connection point, second
09	Valve, differential pressure valve
10	Connection point
11	Drive mechanism, pump, turbine
12	Inflow path
12.1	Section, first
12.2	Section, second
12.3	Section, third
13	Return flow path
14	Partial path
15	Connection
16	Feed-in point, injection point
17	Swirling section, swirling chamber
18	Temperature-control cabinet
19	-
20	-
21	Regulating device, regulating process
22	Destination
23	Connection, releasable
24	Connection, releasable

25	-
26	Line, pipes, hose
27	Entry, leadthrough, rotary leadthrough
28	-
29	Inlet area
30	-
31	Outlet area
32	Opening, inlet
33	Opening, outlet
34	Joint line
35	-
36	Bend
37	Bend

A1 to A3	Surfaces, cross-sectional surfaces
K1 to K3	Nodes
K1' to K2'	Nodes
M1 to M5	Measuring points
R1 to R3	Regulators
S1 to S5	Sensors
T_{ei}	Time constant (subscript i denotes the regulating circuit)
T^*_{ei}	Parameter, replacement constant (subscript i denotes the regulating circuit)
T^{**}_{ei}	Parameter, replacement constant (subscript i denotes the regulating circuit)
T_{Li}	Running time, fluid (subscript i denotes the regulating circuit)
T'_3	Running time, temperature response at the sensor S3

T^*_{Li} Running time, fluid (subscript i denotes the regulating circuit)

T^{**}_{Li} Running time, fluid (subscript i denotes the regulating circuit)

T_V Temperature, flow temperature

V_{AB} Pre-regulating member

V_{NU} Pre-regulating member

V_{DZ} Pre-regulating member

$V_{(i)VH}$ Derivative member (subscript i denotes the control circuit, if provided)

$V_{(i)WF}$ Pre-regulating member (subscript i denotes the control circuit, if provided)

$V_{(i)LZ}$ Pre-regulating member (subscript i denotes the control circuit, if provided)

n Number of revolutions of the machine

$d\Theta_i$ Value, initial value

DeltaΘ_i Deviation

Θ_i Temperature, measured value (subscript i denotes the control circuit)

$ Θ_3 Temperature, measured value, replacement temperature, replacement measured value

$\Theta_{3,soll}$ Command variable, third regulating circuit

$\Theta_{i,soll,k}$ Command variable, corrected (subscript i denotes the control circuit)

$\Theta'_{i,soll}$ Command variable, theoretical (subscript i denotes the control circuit)

$\Theta'_{i,soll,n}$ Command variable (subscript i denotes the control circuit)

Delta	Actuating command
Delta p	Difference in the pressure level